# SPECIAL BULLETIN

OF THE

# AGRICULTURAL EXPERIMENT STATION,

OF THE

# UNIVERSITY OF TENNESSEE,

STATE AGRICULTURAL AND MECHANICAL COLLEGE.

ANALYSES OF COMMERCIAL FERTILIZERS.

B.

OCTOBER 15, 1889.

KNOXVILLE, TENNESSEE,
U. S. A.

# CHEMICAL DIVISION.

## ANALYSES OF FERTILIZERS.

By W. E. Stone.

Samples of the following named commercial fertilizers, for sale within the State, have been collected and forwarded to this Station since May 1, by the State Inspector of fertilizers. Conforming to the law, analyses have been made and are presented here for the benefit of the farming public.

Following the general classification of our Spring bulletin on commercial fertilizers, (Bull. I, Vol. II) the samples include seven *complete* fertilizers, furnishing phosphoric acid, potash and nitrogen, and three *incomplete* articles, of which two only supply only phosphoric acid and the third phosphoric acid and potash.

The guaranteed analyses of the manufacturers are presented in the following table, alongside those made at this Station, with two exceptions, in which cases no guarantee was furnished us by the Inspector. For the sake of clearness, the following explanation of the terms used in describing the different forms of phosphoric acid are repeated from a former bulletin.

"Soluble" is that which can be dissolved in pure water. "Reverted" is that which is insoluble in pure water but is soluble in a weak chemical (ammonium citrate). "Insoluble" is that which is insoluble except in strong acids. The sum of the "soluble" and "reverted" acid makes up the "available" acid, as it is often stated on bags and packages, i. e., the acid which is actually available to the plant. The figures are *percentages* in all cases:

LIST OF BRANDS ANALYSED.

No. 26. "Edisto Dissolved Bone." Makers and guarantee not stated.
No. 27. "Edisto Acid Phosphate." Makers and guarantee not stated.
No. 28. "Currie's Guano." Made by the Currie Fertilizer Company, Louisville, Ky.
No. 29. "Currie's Corn Grower." Made by the Currie Fertilizer Company, Louisville, Ky.
No. 30. "Currie's Falls City Rawbone." Made by the Currie Fertilizer Company, Louisville, Ky.
No. 31. "Currie Wheat Grower." Made by the Currie Fertilizer Company, Louisville, Ky.
No. 32. "Adair's Ammoniated Dissolved Bone." Made by Adair Bros. & Co., Atlanta, Ga.
No. 33. "Furman Tobacco Grower." Made by Furman Farm Improvement Company. Adair Bros. & Co., Atlanta, Ga., General Agents.
No. 34. "Golden Grain Fertilizer." Made by Furman Farm Imyrovement Company. Adair Bros. & Co., Atlanta, Ga., General Agents.
No. 35. "Farish Furman Formula." Made by Furman Farm Improvement Company. Adair Bros. & Co., Atlanta, Ga., General Agents.

| | Moisture. | Phosphoric Acid. | | | | | | | Potential Ammonia | | Potash. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Soluble. | Reverted. | Insoluble. | Total. | Total Guaranteed. | Available. | | Found. | Guaranteed. | Found. | Guaranteed. |
| | | | | | | | Found. | Guaranteed | | | | |
| 26. "Edisto Dissolved Bone," | 15.28 | 9.63 | 5.31 | 1.82 | 16.76 | . . | 14.94 | . . . | . . . | . . . | . . . | . . . |
| 27. "Edisto Acid Phosphate," | 15.93 | 7.54 | 3.98 | 2.30 | 13.82 | . | 11.52 | . . . | . . . | . . . | . . . | . . . |
| 28. "Currie's Guano," | 7.93 | 5.49 | 2.57 | 2.87 | 10.93 | 13.00 | 8.06 | 9.43 | 1.56 | 1.43 | 1.69 | 2 69 |
| 29. "Currie's Corn Grower," | 10.52 | 4.99 | 3.35 | 4.94 | 13 28 | 13.33 | 8.34 | 9.22 | 3.35 | 1.23 | 0.75 | 1.22 |
| 30. "Currie's Falls City Raw Bone," | 9.95 | 5.60 | 3.10 | 8.75 | 17.48 | 15.66 | 8.73 | 9.58 | 1.16 | 1.12 | 1.10 | 0.96 |
| 31. "Currie's Wheat Grower," | 10.69 | 5.07 | 2.46 | 5.48 | 13.01 | 13.33 | 7.53 | 9.22 | 2.64 | 1.23 | 0.72 | 1.22 |
| 32. "Adair's Ammoniated Dissolved Bone," | 16.77 | . . . | . . . | 5.25 | 12.59 | 10.00 | 7.34 | 8.00 | 2.00 | 2.00 | 0.30 | 1.00 |
| 33. "Furman Tobacco Grower," | 11.21 | . . . | . . . | 0.79 | 10.36 | 10.00 | 9.57 | 8.00 | 4.72 | 3.50 | 3.86 | 3.50 |
| 34. "Golden Grain Fertilizer," | 11.65 | . . . | . . . | 1.41 | 12.36 | 10.00 | 10.95 | 8.00 | 3.26 | 2.50 | 2.08 | 2.50 |
| 35. "Farish Furman Formula," | 5.47 | . . . | . . . | 1.75 | 15.19 | 12.00 | 13.44 | 10.00 | . . . | . . . | 3.20 | 2.50 |

# THE AGRICULTURAL EXPERIMENT STATION

## OF THE UNIVERSITY OF TENNESSEE.



The Station has good facilities for analyzing and testing fertilizers, cattle foods, milk and dairy products; seeds, with reference to their purity or germinating power; for identifying grasses and weeds and studying forage plants; for investigating the diseases of fruits and fruit trees, grains and other useful plants; for making reports on injurious insects, and the best means of combating them.

The Bulletins and Reports will be sent, free of charge, to all farmers.

Packages by express, to receive attention, should be *prepaid.*

All communications should be addressed, *not to any individual officer*, but simply to the

EXPERIMENT STATION,

KNOXVILLE, TENN.

☞ The Experiment Station building, containing its offices, laboratories and museum, and the plant-house, and horticultural department are located on the University grounds, fifteen minutes walk from the Custom House in Knoxville. The Experiment Farm stables, milk laboratory, etc., are located one mile west of the University on the Kingston pike. The farmers are especially invited to visit the buildings and experimental grounds.

# SPECIAL BULLETIN

OF THE

# AGRICULTURAL EXPERIMENT STATION,

OF THE

## UNIVERSITY OF TENNESSEE,

STATE AGRICULTURAL and MECHANICAL COLLEGE.

## TREATMENT OF CERTAIN FUNGOUS DISEASES OF PLANTS.

C.

MAY 10, 1890.

These Bulletins will be sent, free of charge, to all farmers applying to the Experiment Station.

KNOXVILLE, TENNESSEE,
U. S. A.

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# BOTANICAL DIVISION.

## The Treatment of Certain Fungous Diseases of Plants.

BY F. LAMSON SCRIBNER.

The injuries suffered by many of our cultivated plants through the attacks of those minute parasitic plants which the botanist names fungi, are often very considerable, sometimes rendering otherwise valuable crops wholly unprofitable. The effects resulting from the action of these parasites are termed diseases—*fungous diseases*. The Black-rot of grapes, the Rust and Mildew of wheat, the Smut of Indian corn and of the smaller grains, the Rot of the Irish potato are all *fungous diseases*, that is they are each due to the direct attacks of a minute fungus. These fungi are, as just stated, little plants too small to be seen with the naked eye and usually very simple in their organization; they are, however, provided with a vegetative system corresponding to the root and stem of higher plants, and abundant means of reproduction. We term the reproductive bodies of fungi *spores*, instead of seeds. The visible smut of wheat is simply a mass of *spores;* each particle, wholly invisible to the naked eye, being a spore. When seeds are placed in certain conditions they germinate and grow into new plants; so with the spores of fungi, if surrounded by suitable conditions, warmth, moisture, etc., they will germinate and grow into new fungi. And as the seeds of different plants require certain soils for their full development, so the different kinds of fungi will only complete their growth on certain of the higher plants. The peculiar species or kind of smut which grows on corn will not grow on wheat and the Downy Mildew which attacks the vine would fail to develop, if its spores germinated on the leaves of the rose.

The planter or fruit grower cannot be expected to investigate the habits and minute structure of the fungi which infest his crops; he knows them by the effects produced and too often suffers seriously in pocket because of the losses they occasion. What he most desires to know is how to prevent the ravages of these pests—smut, rot, mildew, blight, etc., and it is the purpose of this circular to tell how some of them may be overcome, or their attacks prevented. In nearly all cases

the work must be *preventive*, that is we must prevent the fungi from coming on the cultivated plants, or at least prevent the spores which may fall upon them from germinating. Generally speaking, moisture and warmth favor the growth of fungi, and especially is this true of a damp and poorly drained soil. The seasons we cannot control, but we can cease to grow those crops in a locality where they are invariably injured by disease, and we can select good land or render the soil light and free from excessive moisture by proper cultivation and *drainage.* In the case of those plants presenting many varieties, as the grape and the apple, it is well known that some of the varieties are much more subject to disease than others. So far as possible those which are "resistant" to disease should be selected for cultivation, while those most liable to injury from the attacks of fungi should be discarded.

During the past few years active efforts have been made by our government Experiment Stations and even by individuals, to treat these fungous diseases by the direct application of various chemical preparations, chiefly solutions of sulphate of copper, and much progress has been made. We first recommended and used sulphate of copper (blue stone) for Black-rot of grapes, which has proved a successful remedy for this disease.

## Black-rot of Grapes.

*Solutions Used.*—1. Simple solution of sulphate of copper (blue stone): one pound to five gallons of water.

2. Bordeaux mixture: one pound sulphate of copper and one pound fresh unslaked lime to three gallons of water. This is prepared by dissolving the copper sulphate in hot water in one vessel and in another vessel slaking the lime; when both solutions have *cooled to the temperature of the air* the lime is *poured slowly into the copper solution and thoroughly mixed* by stirring.

3. Ammoniacal solution of carbonate of copper: one ounce of carbonate of copper, one pint of aqua ammonia to eight gallons of water. The carbonate of copper (*precipitated*) is dissolved in the ammonia and may thus be kept in a bottle, with a tight-fitting rubber stopper, until required for use, when it is poured into the given amount of water.

*Time of application.*—No. 1, the simple solution, should be applied to the vines as a wash in early spring before the buds have begun to start. No. 2, the Bordeaux mixture, should be applied to the vines when the young shoots are from 4 to 10 inches long and again when they are in blossom. Two or three more applications ought to be made at intervals of from 10 to 15 days, and for these No. 3, or the ammoniacal solution of carbonate of copper, may be used instead of the Bordeaux mixture. The winter treatment—washing the pruned vines with the simple solution of sulphate of copper—and the *early* applica-

tions of the Bordeaux mixture we deem of the highest importance and absolutely necessary to any measure of success. The carbonate of copper solution has not been tested sufficiently to permit us to assert that it may entirely take the place of the Bordeaux mixture. Should it prove of equal value it will be used altogether, as it costs less, is more quickly prepared and far easier to apply. The Bordeaux mixture passes through the spraying pumps with difficulty, owing to the presence of the lime. It has been our custom to strain the lime mixture when it was poured into the copper solution, and again when the compound was poured into the pump.

*Means of application.*—We know of no better apparatus for applying the mixtures named above than the Eureka Sprayer, made by Adam Weaber, of Vineland, N. J. The manner in which this spraying pump is used is illustrated in the annexed figure. The Nixon Nozzle and

Machine Company, of Dayton, Ohio, also make very good spraying pumps which can be used in the vineyard. These pumps are also valuable for spraying trees.

If the Bordeaux mixture is used for the later sprayings, so much of it will be likely to adhere to the berries as to render them unsightly and possibly affect their sale. If this should happen the berries may be quickly cleaned by dipping them, a basket full at a time, into a tub of water to which has been added a pint of vinegar or a very little acetic acid.

*Bagging.*—When one has only a few vines or a small vineyard, the most certain method of preventing the Black-rot is to bag the young clusters. This consists in drawing over the clusters, as soon as the flowers have fallen, paper sacks (manilla bags of the one or two pound size), which are then pinned closely around the stem of the cluster, where they are allowed to remain until the berries are ripe. This treatment not only keeps off the Black-rot but also birds and insects. The fruit colors perfectly but is said not to bear transportation so well as that which is uncovered.

## Apple—Scab.

Like the Black-rot of grapes this disease must be treated preventively.

*Solutions Used.*—1. Ammoniacal solution of carbonate of copper: three ounces of the precipitated carbonate dissolved in one quart of aqua-ammonia. This should be kept in a tight rubber-stoppered bottle until required for use when it is added to thirty gallons of water. One hundred gallons of the diluted solution, is sufficient to spray 50 large, or about 75 medium sized trees once. (*E. S. Goff*, in Bull. 23. Agr. Exp. Sta. of Wisconsin).

*Time of Application.*—The first spraying should be made as soon as the first leaves are fully formed. When the blossoms have fallen a second spraying should be made, and a third when the fruit is one-fourth to one-half grown.

Another preparation which has given excellent results in the treatment of Apple-Scab is *eau celeste*, to which carbonate of soda has been added. The formula recommended is:

| | |
|---|---|
| Sulphate of copper | 1 lb. |
| Carbonate of soda | 2 lbs. |
| Aqua-ammonia | 1½ pts. |
| Water | 30 galls. |

The sulphate of copper is dissolved in hot water and in another vessel the carbonate of soda is dissolved. These two solutions are then mixed and when all chemical reaction has ceased the ammonia is added. This preparation is called "modified eau celeste," or the formula of M. Masson. It was designed especially for treating the Downy Mildew of the grape vine. It should be applied in the same manner as the carbonate of copper solution. Eau celeste without the carbonate of soda is liable to injure or burn the foliage.

In addition to the applications made during the growing season, we would recommend spraying or washing the trees in early spring before the buds start, with a solution of sulphate of copper, one pound to ten gallons of water. The fungus lives through the winter on the young shoots and leaf-buds and this "winter treatment" would serve to check its further development.

Spraying pumps suitable for orchard use are made by the Nixon, Nozzle and Machine Co., Dayton, Ohio; Field Force Pump Co., Lockport, N. Y. and Gould's Manufacturing Co., Seneca, Falls, N. Y.

## Downy Mildew of the Vine.

The same preparations used for Black-rot are excellent for preventing this mildew. The Bordeaux mixture and eau celeste, either with or without the addition of carbonate of soda, have given the best results. To keep this disease off the vines they must be sprayed early in the season as for Black-rot, and one or two sprayings should be made after the fruit is harvested.

## Brown-rot of Grapes.

This disease is caused by the same fungus as causes the Downy Mildew. It should be treated the same as Black-rot.

## Powdery Mildew of the Grape Vine, Gooseberry, Rose and Apple.

The fungi designated "Powdery Mildews" are surface-growing species, that is they grow upon, not within, the plants they infest, they may, therefore, be treated directly by some destructive agent. Sulphur powder or flowers of sulphur, is a long known and much used remedy for these diseases. It is usually applied to the plants through a bellows specially constructed for the purpose. Liquid remedies are often more easily and quickly applied and more certain in their action. The value of sulphur depends very much upon the temperature. At low temperatures it is wholly inert. Sulphuret of potassium (*liver of sulphur*) dissolved in water at the rate of ½ ounce to the gallon serves to destroy the Powdery Mildews and in a measure prevent their further development. It is a remedy which must be used as soon as prepared, and used repeatedly, as its power of action is soon dissipated when exposed to the air.

In the treatment of the Powdery Mildew of the apple—especially destructive to nursery stock—the ammoniacal solution of carbonate of copper has yielded most satisfying results. The formula

| | |
|---|---|
| Carbonate of copper | 3 oz. |
| Aqua-ammonia | 1 qt. |
| Water | 22 gals. |

is essentially the same as that used in treating Black-rot of grapes.

## Leaf-Brownness of the Pear and Quince.

This disease which, is common here, often defoliates the trees by midsummer. The fruit is attacked by the same fungus and more or less injured. Repeated applications of the Bordeaux mixture have entirely preserved the foliage from the fungus, and it is very likely that the ammoniacal carbonate of copper solution would have the same effect.

## Potato-rot.

The rot of the Irish or white potato is referred to here. Plant in a light, sandy loam, or in a soil that is thoroughly well drained; use only perfectly sound seed; spray the tops as soon as they have attained their full size and again two or three weeks later, with the Bordeaux mixture or the ammoniacal solution of carbonate of copper. Store the crop in a cool, *dry* place, and keep them *dry*. Dusting the potatoes with dry, air-slaked lime, at the rate of bushel of the latter to 25 of the former will help to keep their surface dry and materially aid in their preservation. Bulletin No. 2, Vol. 1, of this Station, contains a full discussion of this disease.

## Smuts of Oats and Wheat.

The smuts of these grains are alike in their habits and may be prevented by the same treatment. Soaking the grain to be sown in a solution of sulphate of copper (one pound to a gallon of water) and then spreading it out to dry is a method which has long been practiced and gives fairly good results. The drying of the grain is often hastened by dusting it with land plaster or dry, air-slaked lime. This treatment with sulphate of copper is very liable to injure the germinating power of the grain and it must be practiced with caution. By the *Jensen hot-water treatment* this danger may be avoided and the results, so far as tried, appear to be more certain. This method may be easily and effectually carried out as follows, (we quote from Bulletin No. 8, of the Kansas Experiment Station, p. 95).

Provide two vessels for the hot water of size suited to the amount of seed to be handled. If only a few bushels are to be treated, small vessels will suffice, or one small boiler besides the reservoir that is attached to the stove will be ample. But if a large quantity is to be treated, then two large kettles or one kettle and a large tub should be provided. A sack should be made of loosely-woven cloth, so as to admit the water freely, and of a size suited to the vessel in which it is to be used. Vessel No. 1 (or the stove reservoir) is to be filled with water having a temperature of about 100° to 110° F. Vessel No. 2 should contain water at a temperature of 132° and should remain on the stove so that this temperature can be maintained. The seed-grain is to be enclosed in the sack and then put in vessel No. 1. The object of this immersion is to heat the grain so that when it is removed to vessel No. 2, the temperature will be but slightly reduced. A few minutes immersion in vessel No. 1 will therefore be sufficient, after which the sack of grain should be immersed in vessel No. 2. After a minute or two it should be lifted and stirred about so as to insure contact of the hot water with every grain. This should be repeated several times —oftener, the larger the quantity being treated. After 15 minutes the sack should be lifted from vessel No. 2, and plunged immediately into cold water for the purpose of cooling it quickly. Another portion of the grain can then be treated in a similar manner, and so on until the entire amount is handled. After drying it will be ready for planting. * * * At no time should the temperature of the water in vessel No. 2 fall lower than 130° nor rise higher than 135°.

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## THE COTTON WORM.
## THE HESSIAN FLY.

E.

JULY 20, 1890.

POSTMASTER is required to notify this Station of change of address or failure to deliver.

These Bulletins will be sent, free of charge, to all farmers applying to the Experiment Station,

KNOXVILLE, TENNESSEE,
U. S. A.

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## OF THE UNIVERSITY OF TENNESSEE.

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H. E. SUMMERS, B.S., Entomologist.
L. P. BROWN, Acting Chemist.
R. J. CUMMINGS, Farm Foreman.
W. N. PRICE, Assistant.

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# DIVISION OF ENTOMOLOGY.

BY H. E. SUMMERS.

## I. THE COTTON WORM.

The Cotton Leaf Worm (*Aletia Argillacea*) and its habits in all its stages are too well known to cotton planters to need any description, and we will confine our remarks to means of destroying it.

The arsenites are the only poisons whose use can be said to be fairly out of the experimental stage, and of these Paris Green is used by a large majority of planters, although London Purple is preferred by some. These poisons are applied either dry or wet.

*Dry application of pure Paris Green.* This is the method we would recommend to all planters who do not already own spraying machines, as it appears to be quite as efficient as any other, and does not necessarily involve the purchase of expensive apparatus. The method has only recently come into use. It was first published, we believe, by the Mississippi Experiment Station, and has since been highly recommended by the Alabama Station. The simplest method used in these States is to suspend from each end of a pole eight feet long a bag, 8 by 10 inches in size, made of 8 oz. Osnaburg. Pure dry Paris Green is placed in the bags, the middle of the pole rested on the pommel of a mule's saddle, and the mule ridden between the rows of cotton. With an eight foot pole, four to six rows of cotton can be poisoned at once. The amount of poison used can be increased by shaking the pole more, either by hand or by trotting the mule. This should be so regulated that about one pound is distributed to the acre. The poisoning may be done at any time of the day, although some prefer to do it when the plants are wet with dew or rain; but this does not seem to be at all necessary. A light wind does not interfere, and is thought by some to be of advantage; but a heavy wind prevents the successful application of the poison.

The method described above is the best on small plantations, or in localities where the worm appears only occasionally, on account of there being no expensive apparatus to buy. By it a man and mule can poison from fifteen to twenty acres per day. But on large plantations, especially where the worm is injurious every year, one of the machines named below will probably be better.

*Dry Application of Diluted Paris Green.* Paris Green diluted with flour in different proportions was considerably used before the first method was introduced, and it has been said to have the advantage of sticking to the leaves better, of its being possible to distribute it more evenly over the field, and of requiring less poison. The first of these points is probably true, but the pure poison usually sticks well enough for all practical purposes. The last two points are doubtful, and even if the last be true, the saving on the cost of the poison would be more than counterbalanced by the cost of the flour. If this method is for any reason preferred, however, the bags used must be larger and made of some more open material than the Osnaburg. Cheese cloth has been used for a mixture of one part Paris Green to ten parts of flour.

*Wet Application of Paris Green.* Some believe that there is less danger to workmen and animals when the Paris Green is mixed with water, and for this reason prefer this method. One pound of Paris Green to 40 gallons of water for each acre of land is about the amount that should be used. If the spraying machine used cannot be regulated to use about 40 gallons to the acre, the proportion of poison to water must be changed so that about one pound of the poison will be used to each acre.

A spraying machine is of course necessary with this method.

*London Purple.* This poison is much cheaper than Paris Green, and for that reason is better for those who can succeed with it. When used, *only one half the amount* is required as of Paris Green. Many object to it on account of its greater liability to scorch the plants, but this is probably in great part due to the use of it in the same proportion as Paris Green would be used.

## CAUTION!

The Paris Green, being a dangerous poison, should be handled with due care, and always kept in vessels labelled poison, out of the reach of children and animals.

In applying the poison dry, the rider should keep out of the cloud of dust as much as possible; his hands should be covered, and the portions of his body touching the saddle or mule should have an extra layer of clothing, which should be well shaken every night. Both rider and mule should be washed at night, and

better at noon also. With these precautions there is practically no danger of causing sores where the body is rubbed.

The poison should not be applied by the dry method when a strong wind is blowing towards land used for pasturing.

## SUGGESTIONS.

Poisoning by any of the above methods should be done as soon as the first "crop" of worms is noticed. Although this brood may not itself be so numerous as to do serious damage, by its destruction the following broods are often so decreased, as to render another application of the poison unnecessary; and evenwhere this is not so, and the poison has to be applied again, there will not be the need of the same haste in the second application as there would be if the worms were many times as numerous.

A second application of the poison will usually be necessary if there is a hard rain soon after the first application.

## MAKERS AND SELLERS OF MACHINES.

### FOR DRY APPLICATION.

Jas. P. Roach Manufacturing Co., Vicksburg, Miss. Makers of Roach Cotton Worm Destroyer. Capacity, with one man and two mules, from fifty to sixty acres per day. Price, $75.00, less about 10 per cent. discount.

Sold also by Diamond Huller & Oil Co., Memphis, Tenn.

Leggett & Bro., No. 301 Pearl St., New York. Leggetts' Paris Green or London Purple Gun. A hand machine. Capacity, with one man riding on mule, claimed as forty to fifty acres per day. Price, $12.00.

Thomas Woodson, 451 E. Cambria St., Philadelphia, Pa. Small hand machines.

### FOR WET APPLICATION.

Nixon Nozzle and Machine Co., Dayton, Ohio.
Gould Manufacturing Co., Seneca Falls, N. Y.
Rumsey & Co., Seneca Falls, N. Y.
Field Force Pump Co., Lockport, N. Y.
Thom. Sommerville & Sons, Washington, D. C.
P. C. Lewis, Catskill, N. Y.
J. A. Whitman, Providence, R. I.

For many points in this article we are indebted to information collected by Geo. F. Atkinson, Biologist to the Alabama Experiment Station, published in Bulletin 17 of that Station; and also to Bulletin 12 of the Mississippi Experiment Station.

## II. THE HESSIAN FLY.

The Hessian Fly (*Cecidomyia destructor*) is by far the most important of the wheat pests, in Tennessee as elsewhere, and during the spring of 1889 many inquiries concerning it were received at the Station. For the purpose of gaining some knowledge of its distribution in the State, a circular was sent to many farmers in July, in which answers to the following questions were asked for:

1. Have you observed the Hessian Fly in your locality?

2. In what stages—maggot, flaxseed or adult fly—have you observed it?

3. In what months does the adult fly appear?

4. What years have you seen it, and in which of these years has it been most abundant? Is it abundant this year?

5. What varieties of wheat appear to suffer least from it?

6. What remedies, if any, are used against it in your locality?

7. Have you ever seen it on any other crop than wheat?

Thanks are here extended to those who showed their interest in the work of the Station by replying to the above circular. They were so few in number, however, that the answers were of comparatively little value for the purpose desired. Nevertheless, they showed that the Hessian Fly is destructive throughout the entire State, except in certain localities of very limited extent; and that, while in some parts of the State means are taken to prevent its ravages, in other parts complete ignorance regarding it prevails. As it has been very destructive in some places the present season, it is believed that the following abstract of what is known of it may be of value to many wheat growers.

*The eggs* are laid either singly or in groups of two or three, sometimes more, usually on the upper surface of the leaves of the young winter wheat soon after it appears above the ground in the autumn; sometimes they are deposited on the stalk or under side of leaf. The egg is translucent, of a pale red color, and has the form of a very slender grain of rye (without the groove along the side). Length, about 1–50 of an inch.

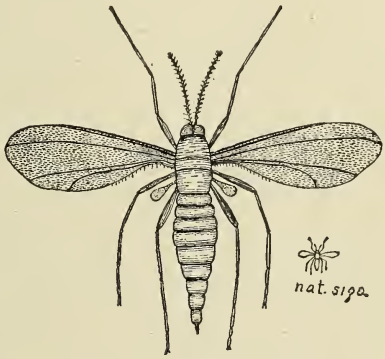
*The larva* or maggot, hatches in about four days after the egg is laid if the weather is warm, in a considerably longer time if it is cool. It at once crawls down inside the sheath to its base, just below the surface of the ground. Here it fixes itself, head downward, to the surface of the stalk, and does not henceforth change its position. Although it does not gnaw the stalk, it gradually becomes imbedded in it by absorbing its substance. In this way, by the direct injuries to the stalk, and by absorbing for its own growth the nourishment that should go to the leaves above, the

plant is weakened, turns yellow, and withers; and when, as often happens, there are many larvæ on one stalk, it dies.

In five to six weeks, the larva has reached its full length of about 3-20 of an inch, and has changed from its original pale red color to an opaque white. It now turns brown, then chestnut, enlarges somewhat, and passes into

*The Pupa* or *Flaxseed Stage.* It is in this form that it is most familiar to the majority of farmers. It is of nearly the form of a flaxseed, but somewhat more flattened, especially at the head end. In this state the insect passes the winter.

*The Imago, or adult fly*, issues from the flaxseed in the warm weather of early spring, in Tennessee late in March and in April. Its form may be better seen from the figure than from a written description. These flies soon begin to lay eggs which will produce another brood, two broods of this insect (sometimes a third) appearing each year. The larvæ, from these eggs, on hatching, pass down to the lower joints of the straw, *above the ground.* Here they grow like those of the other brood, change to flaxseed, and finally issue as adult flies in the late summer and early autumn (July and August), ready to lay their eggs as described above on the winter wheat as soon as it appears above ground.




HESSIAN FLY (*Cecidomyia destructor.*)
(Much enlarged.)

## REMEDIES.

Only one remedy is yet known which is of undoubted value, and this is more difficult of practical application in Tennessee, on account of the uncertainty of autumn frosts, than in more northern portions of the country. It is found that the adult flies which are waiting to deposit their eggs on the young winter wheat are mostly destroyed by the first sharp frost of autumn. By delaying the planting of the wheat, then, until it will not have time to appear above ground until after the first frosts, practically complete immunity, from the ravages of the Hessian Fly may be obtained. If all the farmers of the district would persist in late planting for several years, the fly might be almost exterminated. That it would not be quite so, would be due to the fact that when its favorite food plant, wheat, cannot be found, some few flies will still manage to live upon barley, or some species of grass. It is well to plant a strip of

wheat along one side of the field early, so that it will be well above ground ten days or two weeks before the final planting. The flies will deposit their eggs upon this, and it should then be thoroughly plowed under and replanted with the rest of the field.

Several other remedies have been suggested, among them, pasturing with sheep in autumn and in the spring, burning the stubble, application of lime, rolling the ground when wheat is young, and high culture.

*Pasturing with Sheep* in autumn can evidently be of service only when carried on before the eggs hatch, as after that, as we have seen above, the maggot is below the surface of the ground. Pasturing in spring, to be effectual, must be after the eggs of the summer brood have been laid, as spring pasturing cannot either destroy the flaxseed in the wheat or the adult fly.

*Burning the Stubble* will undoubtedly destroy a large number of insects, but it has the disadvantage of destroying also many parasites of the Hessian Fly, which are also in the straw, and would issue later to feed upon the young maggots of the next brood of flies. Some writers have even claimed that the harm done by the destruction of these parasites more than counterbalances the good done; but this is doubtful.

*High Culture* cannot properly be considered a remedy for the Hessian Fly, as their numbers are not at all decreased by it: it simply enables the plants better to withstand the injury done by them.

The other remedies mentioned, together with others not named, are of uncertain benefit.

The one remedy that is of undoubted practical use, and which we strongly urge all wheat growers to pursue, is *late planting*, combined with the early planting of a small strip to be plowed under just before the final sowing.

The bearded varieties of wheat seem moreover to be less susceptible to the attacks of the fly, and should accordingly be selected when convenient.